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Investigation of oxygen saturation levels in respiratory system diseases in the covid-19 pandemic

Respiratory failure and oxygen saturation levels

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Abstract
Aim: In the Covid-19 pandemic, it is seen that patients remain hypoxic in the long term and their SpO2 values decrease. The aim of this study was to evaluate the SpO2 levels in cases transported to the hospital by 112 ambulance and to investigate the correlation of the data results with respiratory system diseases and COPD patients, which is the group most frequently transported to the hospital.
Material and Methods: We examined the SpO2 values of patients who were transported by 112 emergency ambulance with shortness of breath during the long period of the pandemic. We examined 270,753 patients who were transported between March-September 2020, 2021, 2022. The patients were divided into two groups according to the degree of saturation: saturation between 86-90% and below 85%.
Results: We statistically analyzed the saturation levels of the patients by year and month. There was no statistically significant relationship in terms of the number of transported cases by years and months in patients with a saturation below 85% (p=0.908). There was a significant correlation between years and months in patients with 86-90% saturation (p=0.029). There was a statistically significant relationship between the saturation levels of the cases carried by years (p=0.017). In 2021-2022, the percentage of patients with both saturation below 85% and between 86-90% increased compared to 2020 (p=0.003; p=0.015).
Discussion: According to the results of the study, the low oxygen levels of the patients who were transported to the hospital with shortness of breath increased in the 1st and 2nd years compared to the beginning of the pandemic.

Keywords
Long COVID-19 Syndrome, Dyspnea, Hypoxemia, Pulse Oximetry

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Introduction

Coronavirus Disease-2019" (COVID-19) has become an epidemic in a short time and become a global concern due to being an easily transmitted disease. Signs and symptoms seen in the acute phase of the coronavirus disease are now better defined. Among them, the most common are cough, shortness of breath, fever and sometimes acute respiratory distress [1]. More than 70% of COVID-19 survivors had a disorder in one or more organs 3 to 4 months after the first symptoms [2,3]. The symptoms seen in the long term after the acute illness were have been named "long haulers", or patients living with "Chronic COVID syndrome", "post-COVID-19 syndrome", or "post-acute-COVID-19" [4,5].

In the long COVID-19 Syndrome, extensive symptoms such as shortness of breath, chronic cough, chest tightness, cognitive dysfunction, and extreme fatigue have been reported by recovering patients [6,7]. Chronic obstructive pulmonary disease (COPD) is a respiratory disease characterized by progressive airflow limitation affecting more than 5% of the world's population. Exacerbation attacks seen in the course of the disease cause worsening of the patient's respiratory symptoms and change of medication. Tracheobronchial infections are the leading cause of COPD exacerbations. Most of these infections are caused by viral infections.

At the beginning of the pandemic, all pulmonologists worldwide expected that COPD patients would be hospitalized more frequently for exacerbations and pneumonia, and that mortality would be higher in these patients due to complications. However, COPD patients in the patient groups admitted to the hospital in the following days were not as high as expected [8,9] It is also predicted that this expected height will appear in the coming years of COVID. The aim of this study was to evaluate the SpO_2 levels in cases admitted to the hospital by 112 ambulances and to investigate the correlation of the data results with respiratory system diseases and COPD patients, which is the group most frequently transported to the hospital.

Material and Methods

Between March and September 2020, 2021, 2022, patients who were transported to the emergency services by ambulance with suspected COVID-19 and complaints of shortness of breath were examined. Specifically, the purpose of selecting these periods is to examine population-wide saturation levels that underlie prolonged COVID-19 symptoms, using data from the onset of the pandemic, 1 year and 2 years after onset. A total of 270,753 patients were reviewed retrospectively at the specified times.

Patients diagnosed with COPD, COPD attack, asthma attack, viral pneumonia, bacterial pneumonia, lower respiratory tract disease, bronchitis, bronchiolitis were examined. The patients were evaluated according to their saturation and divided into two groups: saturation between 86-90% and below 85%. Patients with a saturation SpO_2 below 85% were considered to be severely hypoxic, and patients with an SpO_2 between 86-90% were considered to be moderately hypoxic. In addition, we divided the months into two groups: March-April-May and June-July-August-September to examine whether there is a difference between the months. We looked at the statistical relationship between saturation levels among these groups. The purpose of selecting these periods was to look at data from the onset of the pandemic and at 1 and 2 years after onset to address population-wide saturation levels that underlie prolonged COVID-19 symptoms.

This study was approved by the Izmir Bakircay University Ethics Committee for Non-Interventional Clinical Trials (Approval no: 869/849) (2023/02-01).

Statistical analysis

Data were evaluated in the statistical package program IBM SPSS Statistics 25.0 (IBM Corp., Armonk, New York, USA). Descriptive statistics were presented as frequency (n) and percentage (%). The Cochran-Armitage test was used to determine the relationship between years and the number of admitted cases. A value of $p<0.05$ was considered statistically significant.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

In our study, 270.753 patients who were transported to the emergency room by ambulance with the complaint of shortness of breath were examined. The number of cases transported is shown in Table 1 according to months and years. There was no statistically significant relationship in terms of the number of cases transported by years and months in patients with saturation below 85% (p=0.908). There was a significant correlation between years and months in patients with 86-90% saturation (p=0.029). In 2021, the percentage of cases admitted in both March-April-May and June-July-August-September increased compared to 2020 (p<0.001). In 2022, the percentage of cases carried in March-April-May decreased compared to 2020. The percentage of cases admitted in June-July-August-September increased compared to 2020 (p=0.027). There was no significant relationship in terms of the number of admitted cases by month between 2021-2022 (p=0.144).

Table 1. Number of cases admitted by year and month.

Saturation	Years	Months		p
		March-April-May	June-July-August-September	
< 85%	2020	1037 (%29,6)	1111 (%27,7)	0,908
	2021	1293 (%36,9)	1629 (%40,6)	
	2022	1171 (%33,4)	1273 (%31,7)	
86-90%	2020	1063 (%33,0)	1185 (%29,3)	0,029
	2021	1138 (%35,4)	1573 (%38,8)	
	2022	1017 (%31,6)	1293 (%31,9)	

Table 2. Comparison of saturation levels by years.

	Saturation		p
	< 85%	86-90%	
2020	2148 (%28,6)	2248 (%30,9)	0,017
2021	2922 (%38,9)	2711 (%37,3)	
2022	2444 (%32,5)	2310 (%31,8)	

The saturation levels of the admitted cases by year are shown in Table 2. There was a statistically significant relationship between the saturation levels of the admitted cases by years (p=0.017). In 2021 and 2022, the percentage of patients with both saturation below 85% and between 86-90% increased compared to 2020 (p=0.003; p=0.015, respectively). There was no significant relationship between the years 2021-2022 in terms of the number of cases transported according to the saturation level (p=0.638).

Discussion

Severe acute respiratory syndrome coronavirus-2 (SARS CoV-2) primarily targets the respiratory system, causing respiratory and multiorgan failure [10]. Dyspnea (shortness of breath) is an important clinical finding in respiratory system diseases [11,12]. Hypoxemia in COVID-19 is similar to community-acquired pneumonia or interstitial lung disease; it results from intrapulmonary shunts, loss of lung perfusion regulation, intravascular microthromboembolism, impaired diffusion capacity, and preservation of lung mechanics [13,14].

The pulse oximeter is placed on the skin, then the skin is illuminated and SaO_2 is assessed by measuring changes in the light absorption of oxyhemoglobin and reduced Hb [15]. With pulse oximetry, patients' arterial oxygen saturation levels and respiratory functions are measured non-invasively [16]. Oxygen saturation is a vital parameter used in the initial evaluation of patients in need of oxygen. It is now described as the 5th vital sign. It is one of the most important parameters used to evaluate the need and response of patients to oxygen therapy [17]. With pulse oximetry, which is an indicator of the adequacy of ventilation, the normal O_2 value (SpO_2) was found to be 95-100%. The classification of hypoxia according to pulse oximetry values is carried out as follows [18]: SpO_2 95-100% Normal, SpO_2 91-94% Mild hypoxia, SpO_2 86-90% Moderate hypoxia, SpO_2<85% Severe hypoxia.

According to studies, as with other respiratory diseases, COVID-19 patients, with oxygen saturation (SpO_2)<85% in room air are at high risk [19,20]. Causes of hypoxia seen in COVID-19; Impairment of lung perfusion is caused by intrapulmonary shunts, microthromboembolism and impaired diffusion capacity [21,22]. "Silent" or "happy" hypoxemia, which is a feeling of disproportionate shortness of breath with low hypoxemia, is seen in other diseases of the respiratory system and COVID-19 disease. Although the mechanism of this silent hypoxemia is not fully understood, its rates are not fully known [23].

In this study, we examined the SpO_2 levels of the patients who were transported by the 112 emergency ambulance with the complaint of shortness of breath. When we examined by years, it was found that the the number of patients who were transported with severe hypoxia and moderate hypoxia in the 1st and 2nd years of the pandemic was statistically significant compared to the number of patients transported at the beginning of the pandemic. Rahman et al. showed a decrease in SpO_2 levels in their study [24].

When we examined patients with SpO_2<85%, no significant difference was found in the number of cases according to months and years. It was observed that the number of patients with moderate hypoxia increased in the 1st year of the pandemic compared to the beginning of the pandemic, but decreased in the winter months of the 2nd year of the pandemic compared to the beginning of the pandemic.

We can attribute this to the fact that seasonal epidemics could not show the expected effect due to the COVID-19 epidemic and personal protective measures such as mask use, social distancing and hand hygiene. Similarly, studies have found that there is a significant decrease in pneumonia and shortness of breath complaints due to all other factors during the COVID-19 pandemic [23-25].

Through statistical analysis, we've observed a noteworthy rise in patients' saturation levels during the initial two years of the pandemic. This pattern of increased saturation levels was evident in two distinct groups: one where saturation levels fell below 85%, and the other where levels ranged from 86% to 90%. Notably, this rising trend was not influenced by any specific months within these years, underscoring the fact that the increase was consistent throughout this period.

The primary objective of this research, as stated in the manuscript's introduction, is to examine the saturation levels, which are critical to understanding long-term COVID-19 symptoms, such as shortness of breath. These symptoms often necessitate hospitalization. The data under consideration for this study spans from the initial emergence of the pandemic and continues through the first and second years following the outbreak.

In the 2nd year of the pandemic, we saw that the SpO_2 levels of patients who were transported with 112 decreased significantly. In COVID-19 patients, the clinic can range from asymptomatic to severe pneumonia causing acute respiratory distress syndrome (ARDS). During this period, SpO_2 monitoring with pulse oximetry is recommended for patients who are in the risk group, especially for silent hypoxia in prolonged COVID-19.

Study Limitations

The most important limitation of our study was that outpatient hospital admissions were not included in the study population.

Conclusion

According to the results of the study, the low oxygen levels of the patients who were transported to the hospital with shortness of breath increased in the 1st and 2nd years compared to the beginning of the pandemic.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

1. Maury A, Lyoubi A, Peiffer-Smadja N, De Broucker T, Meppiel E. Neurological

manifestations associated with SARS-CoV-2 and other coronaviruses: A narrative review for clinicians. Rev Neurol. 2021;177(1-2): 51-64.
2. Premraj L, Kannapadi NV, Briggs J, Seal SM, Battaglini D, Fanning J, et al. Mid and long-term neurological and neuropsychiatric manifestations of post-COVID-19 syndrome: A meta-analysis. J Neurol Sci. 2022; 434: 120162.
3. Dennis A, Wamil M, Alberts J, Oben J, Cuthbertson DJ, Wootton D, et al. Multiorgan impairment in low-risk individuals with post-COVID-19 syndrome: a prospective, community-based study. BMJ Open. 2021;11(3): 048391.
4. Rubin R. As Their Numbers Grow, COVID-19 "Long Haulers" Stump Experts. JAMA. 2020; 324(14):1381-3.
5. Greenhalgh T, Knight M, A'Court C, Buxton M, Husain L. Management of post-acute covid-19 in primary care. BMJ. 2020; 370: m3026.
6. Venkatesan P. NICE guideline on long COVID. Lancet Respir Med. 2021; 9(2):129.
7. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, Sepulveda R, Rebolledo PA, Cuapio A, et al. More than 50 long-term effects of COVID-19: a systematic review and meta-analysis. Sci Rep. 2021;11(1):16144.
8. Pauwels R. Global initiative for chronic obstructive lung diseases (GOLD): time to act. Eur Respir J. 2020; 18(6):901-2.
9. Wu F, Zhou Y, Wang Z, Xie M, Shi Z, Tang Z, et al. Clinical characteristics of COVID-19 infection in chronic obstructive pulmonary disease: a multicenter, retrospective, observational study. J Thorac Dis. 2020;12(5):1811-23.
10. Tzotzos SJ, Fischer B, Fischer H, Zeitlinger M. Incidence of ARDS and outcomes in hospitalized patients with COVID-19: A global literature survey. Crit Care. 2020; 24(1):516.
11. Miravitlles M, Anzueto A, Legnani D, Forstmeier L, Fargel M. Patient's perception of exacerbations of COPD-the perceive study. Respir Med. 2006; 2(3):453-60.
12. Marrie TJ, Lau CY, Wheeler SL, Wong CJ, Feagan BG. Predictors of symptom resolution in patients with community-acquired pneumonia. Clin Infect Dis. 2000; 31(6):1362-7.
13. Lang M, Som A, Mendoza DP, Flores EJ, Reid N, Carey D, et al. Hypoxaemia related to COVID-19: vascular and perfusion abnormalities on dual-energy CT. Lancet Infect Dis. 2020; 20(12): 1365-6.
14. Bora ES, Erdoğan MA, Özkul B, Sever IH, Söğüt İ, Hürdağ C, et al. Short term protective effect of digitoxin in sepsis-induced acute lung injury. Biocell. 2022;46(2):433.
15. Ottestad W, Kåsin JI, Høiseth LØ. Arterial oxygen saturation, pulse oximetry, and cerebral and tissue oximetry in hypobaric hypoxia. Aerosp Med Hum Perform. 2018; 89(12):1045-9.
16. Jubran A. Pulse oximetry. Intensive Care Med. 2004; 30(11):29-32
17. Quaresima V, Ferrari M. COVID-19: efficacy of prehospital pulse oximetry for early detection of silent hypoxemia. Crit Care. 2020, 24(1):501.
18. Valdez-Lowe, Ghareeb SA, Artnian NT. Pulse oximetry in adults. Am J Nurs. 2009; 109(6):52-9.
19. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020; 395(10229):1054-62.
20. Gattinoni L, Coppola S, Cressoni M, Busana M, Rossi S, Chiumello D. COVID-19 does not lead to a "typical" acute respiratory distress syndrome. AmJ Respir Crit Care Med. 2020; 201(10):1299-300.
21. Liu Y, Yang Y, Zhang C, Huang F, Wang F, Yuan J, et al. Clinical and biochemical indexes from 2019-nCoV infected patients linked to viral loads and lung injury. Science China Life Sciences. 2020; 63: 364-74.
22. Ackermann M, Verleden SE, Kuehnel M, Haverich A, Welte T, Laenger F, et al. Pulmonary vascular endothelialitis, thrombosis, and angiogenesis in Covid-19. New England Journal of Medicine. 2020; 383(2): 120-8.
23. Fuehner T, Renger I, Welte T, Freundt T, Gottlieb J. Silent hypoxia in COVID-19: a case series. Respiration. 2022; 101(4): 376-80.
24. Rahman A, Tabassum T, Araf Y, Al Nahid A, Ullah MA, Hosen MJ. Silent hypoxia in COVID-19: pathomechanism and possible management strategy. Molecular biology reports. 2021; 48(4): 3863-9.
25. Sullivan SG, Carlson S, Cheng AC, Chilver MB, Dwyer DE, Irwin M, et al. Where has all the influenza gone? The impact of COVID-19 on the circulation of influenza and other respiratory viruses, Australia, March to September 2020. Eurosurveillance. 2020; 25(47): 2001847.

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